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A MODEL FOR PROJECTING ARMY INDUSTRIAL FUND CASH REQUIREMENTS.(U)
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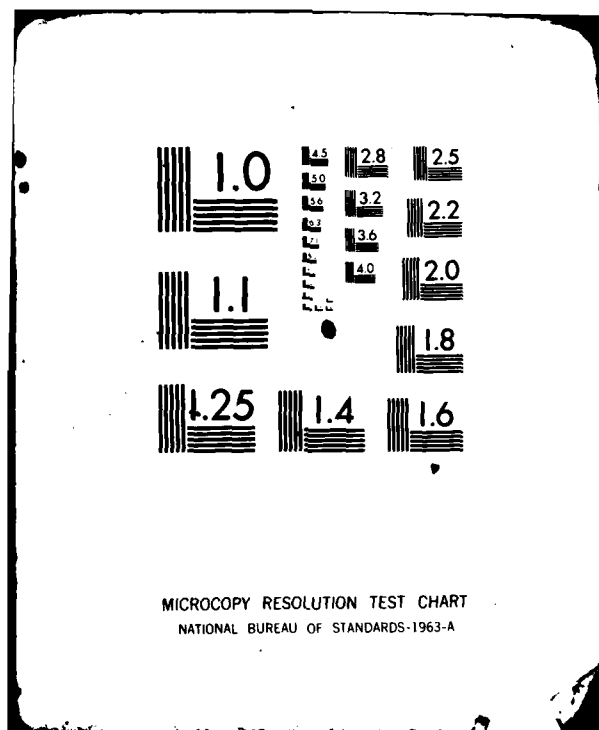
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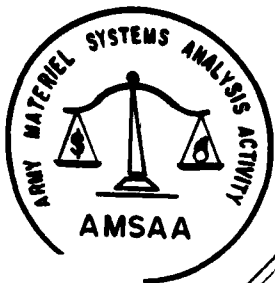
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**A MODEL FOR
PROJECTING ARMY
INDUSTRIAL FUND CASH
REQUIREMENTS**

**INVENTORY
RESEARCH
OFFICE**

April 1982

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US Army Materiel Systems Analysis Activity
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Philadelphia, PA 19106

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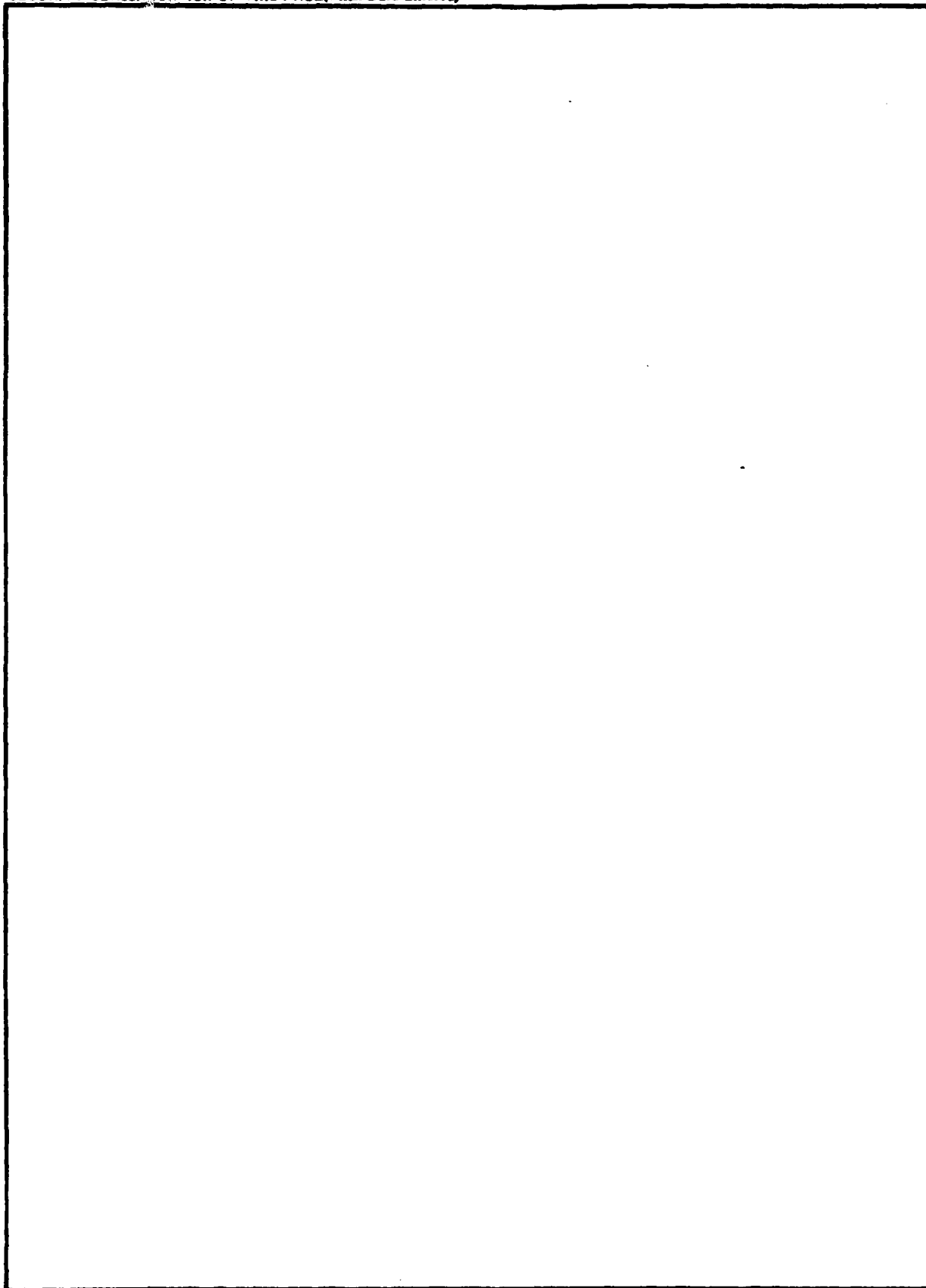
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Jim McGlone, the project sponsor, played an active role in the conduct of the study from fact finding to final report. The Appendix of this report in particular bears his stamp. Pete Fiume and Jeff Greenwood at US Army Depot Systems Command were patient teachers and collected the data used in the retrospective task. Mike Wajda performed the parallel test in an outstanding manner, mastering a computer system which was research, not user oriented. Henry Goethe, Dick Waibel and Bernie McCullough played important roles in the fact finding which led to generalization of the model from the depots to other AIF activities.

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1. CASH FLOW MODEL

1.1 Introduction.

The Army Inventory Research Office was tasked by Army Development and Readiness Command (DARCOM, DRCCP-FP) to develop a cash flow model for Army Industrial Fund (AIF) activities. ~~This tasking was part of a broader DARCOM effort~~ to improve the management of cash. The overall objective was to reduce cash requirements while protecting against disruptions caused by cash shortfalls.

It should be pointed out that when we refer to "cash", we do not literally mean currency or deposits at private banks. Cash represents the ability to issue checks against the Federal Reserve System. The impact of a reduction in AIF cash requirements would be a reduction in required budgetary obligation authority. In a year in which this occurred, obligation authority conserved could be applied to other Department of Defense needs.

Here is how the "AIF Cash Flow Model" will contribute to DARCOM's goals. The model will project future end of month cash balances, for up to 12 months into the future, assuming there is no management intervention. If shortfalls are projected, management actions, including a request for additional cash can be initiated. Conversely, if balances will be higher than necessary to provide a margin of safety, cash requirements can be reduced and obligation authority conserved. This margin of safety must protect against daily fluctuations, and forecast errors.

The Appendix of this report documents the model formulas and specifies the model inputs. It is written in the format of a User's Guide and has indeed served that purpose. In the rest of this section we will provide the background necessary to understand the model and appreciate why it took the form it did. We will also discuss test experience with the model.

1.2 Terminology.

A collection is an increase in cash which results from installation activities, and a disbursement is a decrease in cash. The only other way cash can change is through capital infusions or withdrawals made by higher authority.

An expense is the use or receipt of a good or service. An expense may result in an immediate disbursement or in a payable. In AIF accounting the term "cost incurred" is prominent. It is literally a measure of costs incurred in performance of specific job orders. Unlike expenses, which refer to specific tangible transactions, cost incurred is really a rigorously developed estimate.

Reimbursement accrued, as the term is used in the cash flow model, is the provision of goods and services which will result in collections at the next billing cycle. It differs from revenue earned because of progress billing. Under progress billing, even though revenue may not be earned until a particular output is produced, such as an overhauled truck, collections are made as resources are expended.

The significance of revenue earned is that total progress billings for a job order cannot exceed the total revenue which will be earned when the job is completed. Once this revenue ceiling is hit, progress billing ceases and losses are taken. Conversely, if revenue earned exceeds what would be billed under progress billing, a profit is collected.

We will refer to "unchanged progress billed direct hours" and "changed progress billed direct hours". When a job order is signed between an AIF activity and a customer, the price to be charged is based on estimated labor and overhead rates. If the original estimates are used in progress billing throughout the life of the job order, we have "unchanged progress billed direct hours". If progress billing always reflects the latest estimates, which may be updated quarterly and will reflect pay increases and so on, we have "changed progress billed direct hours". Note that if there are no losses, changed progress billed direct hours will equal cost incurred.

1.3 Depot AIF's.

At FY81 year end, DARCOM AIF activities had \$175 million of cash of which \$99 million was held by the CONUS depots. The initial model development focused on the depots, and it is with depot data that the model was validated.

At the depots, the most commonly used job order is fixed price. The depot contracts to do a specific amount of work at a specific price, e.g. overhaul 100 tanks at \$10,000 each. "Changed progress billed direct hours" are used. Losses are taken only if cumulative progress billings would exceed the value of the job order, and profits are made only when the value of completed work exceeds billings.

Typically, there are two billing cycles a month, covering days 1-15, and the rest of the month. There is a lag of perhaps 5 to 13 days between the cutoff date for billing and when Depot Systems Command makes the computer run that actually results in a cash transfer to the depot. Thus, at month end, activity in days 15-30 has led to expense and accrued reimbursement, but not to cash.

Depot work centers are labelled as direct or indirect according to the type of service they provide. Direct work centers perform work easily identifiable to a specific job order, e.g. engine work on the tank. Indirect labor support the direct labor, whether it be personnel support or the base fire department. Each direct work center has a "standard" labor rate reflecting its hourly wages. Direct labor cost incurred is computed as the standard labor rate multiplied by direct hours. Direct hours include hours worked by other than supervisory and staff people in the work center. They would exclude training hours.

Material used by the direct work centers is charged to a job order as direct materiel cost incurred when the work center receives the materiel from the installation supply activity. Occasionally, there are items such as equipment rentals which are categorized as direct other costs incurred.

All costs which are not considered direct labor, direct materiel or direct other are charged to overhead and are recovered by applying an overhead rate to each direct hour worked. For FY81, 23% of DARCOM AIF cost incurred was labor overhead, while 12% of total cost incurred was non-labor overhead.

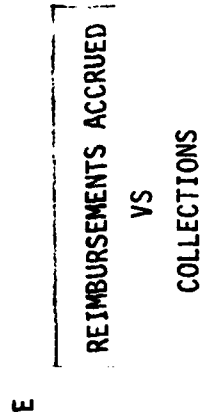
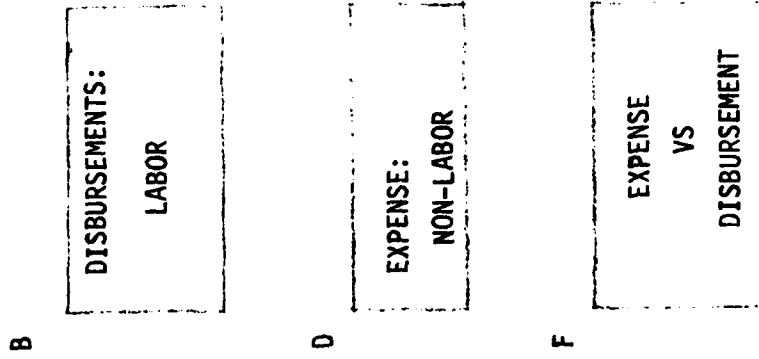
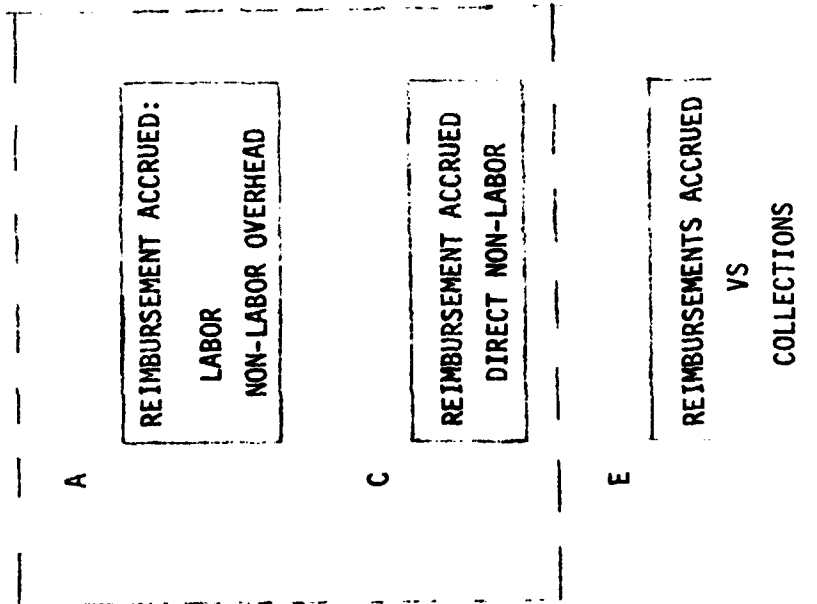
While the overhead rate is based on past experience, it is an estimate arrived at by AIF personnel and designed to capture future costs. In addition, the depot may be directed to add a profit to overhead to compensate for past losses, or a loss to compensate for past profit.

1.4 Cash Flow Model Design

The figure on the next page depicts the building blocks of the cash flow model. Reimbursements accrued are estimated (Blocks A and C) and the lag between reimbursements accrued and collections is accounted for (Block E). Labor disbursements, i.e. payroll, are estimated (Block B). Other expenses are estimated (Block D) and the difference between these expenses and the resulting disbursements are then accounted for (Block F).

Block A. The heart of this block is a rather involved procedure for estimating direct hours over the future time period of interest. Reimbursement for direct labor is then the standard labor rate multiplied by direct hours, and reimbursement for overhead is the overhead rate times direct hours. Both rates are input to the model. The standard labor rate input is a composite rate based on the rates applied at each work center. It has many uses, and

CASH MODEL BUILDING BLOCKS



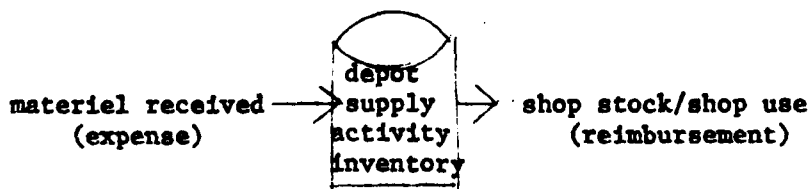
was available prior to the development of the cash flow model.

The procedure for estimating future direct hours takes account of recent historical experience with hours worked, and leave factors based on 1-3 years of history. The past two months of history are used to estimate how many direct hours would be accumulated each working day if no leave were taken. Then the leave factors are applied. The leave factors indicate the average percent leave taken (including holidays) in each 1/2 month period during the year. A kind of computerized calendar is also used by the cash flow model so that the number of calendar days in the period of interest can be converted into the exact number of week days.

Block B. The scheduled disbursement dates for all future payrolls are known years in advance. The dollar value of each future payroll is estimated from the average of the four most recent past payrolls. Expected pay increases (percent) may be input into the model, but this is not always necessary (see section on "profits, losses and inflation").

Blocks C and D. In the current version of the cash flow model, these building blocks are crafted in the simplest possible fashion. One reason is that it is labor which accounts for the most dollars. Another, is that a more accurate treatment would have to forecast fluctuations in the depot supply activity inventory. To do this with any accuracy would require a procedure such as that used at the Army National Inventory Control Points in implementation of DoDI 4140.24.* This procedure requires computer programs far more complex than the entire current cash flow model. Statistical approaches combined with inventory analyses might offer some promise, and could be developed as a future model refinement.

The relationship between inventory and cash follows from the flow of materiel:



* DoDI 4140.24, "Requirements Priority and Asset Application for Secondary Items," September 1969.

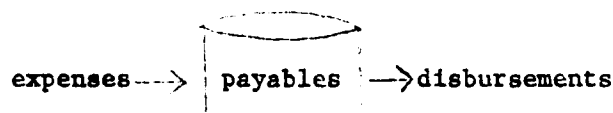
Expense is incurred when the depot receives the materiel into its general inventory, while cost is incurred, i.e. reimbursement accrued, when the shop obtains the materiel for a specific job order.

Fluctuations in supply activity inventories represent an imbalance between the flow into inventory, or expense, and the flow out of inventory or reimbursement. This imbalance between expense and reimbursement causes the fluctuations in cash.

The purpose of the simplified building Blocks C and D in the current cash model is to provide inputs to Blocks E and F. It is assumed expenses and reimbursements are equal, but that there is a cash impact because of the delays between accrued reimbursements and collections, and between expenses and disbursements.

It was already explained in the discussion of Block A that non-labor overhead reimbursement is estimated as (direct labor hours) x (non-labor overhead rate). Expenses are estimated using the same rate. Analogously, the historical ratio of direct materiel cost incurred to direct hours worked is computed in the model, and then this ratio is used as a rate in estimating both future direct materiel expense and reimbursement. Four months of history were found to give the most accurate ratio.

Block E. The flows into and out of payables impact cash just opposite to the flows into and out of materiel inventory:



If the level of payables drops during a month, this means that during that month disbursements (out flow) exceeded expenses (in flow), and visa versa.

Algebraically,

$$\text{Disbursements} = (\text{Old Payables} - \text{New Payables}) + \text{Expenses}$$

where old payables refers to payables at the beginning of the month, and new payables refers to payables at the end of the month.

Most payables are short term in nature, so it would be of limited value, as well as quite laborious, to estimate future payables based on what was due out when the model is run. Instead historical experience is used to estimate the number of days of expenses which payables represent on average. For example, if expenses average \$10,000 a day and payables average \$200,000, then payables are 20 days of expenses ($200,000 \div 10,000$). It is then assumed that in the future

payables will be at this average. This is not true, payables fluctuate, but the average is the best guess.

A year of historical experience is recommended for estimating payable days unless there is reason to believe only the most recent months are representative of current conditions.

Block F. The number of unreimbursed days at months end is input to the model. This is the calendar period for which no billing has yet been made. The model estimates accrued reimbursement for this period just as if it were in the future, and credits these dollars as contributors to cash in the next month. To balance this, unreimbursed days for future months is also input. For example, if cutoff date for the model is 31 January, and if a forecast is made for February thru June, the model will credit cash with estimated accrued reimbursement for the period 16 January-31 January but will not credit cash for reimbursement for the period 16 June-30 June.

An alternative to the approach described would have been to input actual accrued (uncollected) reimbursement as of 31 January. There was no simple way to obtain this figure.

At the depots unreimbursed calendar days generally varies from 13 (February cutoff, days 16-28) to 16. An exception is that three billing cycles may be run in September. At other AIF activities unreimbursed calendar days may be more variable. For example, with weekly billing and no lag, unreimbursed days can vary from 0 to 6.

1.5 Other Issues

Local Collections. There are various sources of local collections. At Letterkenny Army Depot important sources are refunds of travel and other advances made to employees, and bonds posted by contractors bidding for jobs. While these local collections increase cash, there are offsetting entries that on average tend to cancel them out, so local collections are excluded from the model. Specifically, while Letterkenny is collecting in January for travel advances made in December, but not needed, it is also making new advances in January which will not be needed, which tends to cancel out the collecting. Corresponding to bonds for bids received are refunds of bonds.

There are local collections such as issuance of hunting licenses which represent collections without corresponding disbursements. These were not

significant sources of funds at the depots.

1.6 Profits, Losses and Inflation

Pay increases can be recovered by raising labor and overhead rates; under changed rate progress billing the immediate impact is limited to an increase in the value of end of the month reimbursements accrued but not collected.

However, inflation will impact profit and loss if it has not been accurately factored into the prices depots negotiate for fixed price job orders. And it will impact gains and losses from inventory due to price changes. Both the prices paid by the depot to government suppliers and the prices received by the depot supply activity from the shops reflect the prices posted in the Army Master Data File. When an increase occurs, the price of all existing depot supply activity inventory is marked up.

The cash model relies on the budget people who set the standard labor rates and overhead rates and assess the impact of inflation to adjust the cash model projections appropriately for inflation. It assumes that profits and losses due to errors in prices charged unrelated to inflation will tend to cancel each other out.

The model provides one output designed to assist the budget people. It projects whether current labor rates, direct and overhead, are in balance with current payroll costs. It does this by comparing average payroll per month to average labor cost incurred per month, given current labor rates.

Depot vs Treasury Cash. The official cash position for a depot is the "Treasury" balance which is actually maintained by US Army Finance and Accounting Center. This balance differs from the depot balance because it includes the impact of TBO's/TFO's (Transfers by/for others) which can sometimes be processed by USAFAC before they are processed by the depot. Furthermore, the depot may not even show a payable for a charge already processed against its cash by USAFAC. This can occur, for example, when materiel is purchased from an Army Inventory Control Point, the materiel has been shipped, but has not yet been received at the depot.

The treasury balance is more current and so would be preferred to the depot balance for input to the cash model. However, the end of month Treasury balance will generally not be available by the time the other data needed to run the

model has been gathered. It is more important to run the model in a timely manner than to get the Treasury balance.

1.7 Validation

Two separate tests were run, both involving the Anniston (ANAD), Letterkenny (LEAD) and Red River (RRAD) depots. In the first test, data were given to us for February 1979 thru June 1980. We ran the model with data cutoff dates of June 1979, September 1979 and December 1979. The forecasts were compared to actuals and are termed retrospective results in Table 1. While the model forecasts by month, the lowest month in each quarter was recorded for evaluation purposes.

Consider the first line of Table 1. This line reports results based on the June 1979 cutoff. The first column states that Anniston's lowest end of month cash balance among the months April, May and June 1979 was \$16.8 million. The model forecasted that the lowest balance among the months July, August and September would be \$13.8 million, and among October, November and December it forecasted a low of \$12.8 million. In both cases there was a negative error, meaning that actual exceeded forecast.

In the second test, the model was run by DESCOM personnel as data became available. The test covered a shorter period of time and forecasts were made only up to five months ahead. The first forecast was made with a November 1980 cutoff, and the last forecast had an April 1981 cutoff. Ideally, we would have liked to evaluate quarterly forecasts made in November, February (3 months after November) and May, but since May was not available, we used November, February and April. Results are in Table 2 and are termed "pilot test" results.

In computing forecast errors, actual depot cash balances were adjusted for capital allocations and withdrawals. These are transfers of cash between AIF activities, or even from other budget accounts, made by higher authority. For example, in both November 1979 and January 1980 Red River was given \$2 million. In evaluating the forecast made in September 1979, the Red River January 1980 actual cash balance was first dropped \$4 million to what it would have been without the cash allocations. In evaluating the December 1979 forecast, January's actual balance was dropped only \$2 million - the November allocation was already reflected in the December cash balance input to the model for the December forecast.

As a standard of comparison, forecast errors were computed assuming the last quarter's actual was extrapolated to all future months, e.g. the Anniston June 1979 forecast would be \$16.8 million for all future months since the lowest actual in April-June was \$16.8 million. Among very simple approaches this seems the most reasonable. Forecast errors were again adjusted to account for capital transfers.

Average unsigned errors* were:

TEST	QTR AHEAD	AVE UNSIGNED ERROR (MILLIONS)	
		MODEL	STANDARD
RETROSPECTIVE	1	\$2.2	\$2.5
	2	\$3.0	\$3.2
PILOT	1	\$1.6	\$2.0

Improvement using the model, as shown, varied between 6 percent and 25 percent. The model offers the additional advantage of projecting where it believes cash is going, not just where it is currently. It is also anticipated that with use refinements will be found.

If we could assume errors are Normally distributed, standard deviation would equal 1.25 times average unsigned errors.** Two standard deviations would therefore be about \$5 million for 1 qtr ahead model forecasts (based on average unsigned error of \$2 million), and \$7.5 million for 2 qtrs ahead. Given the Normal assumption, we would expect 1 qtr ahead "+" error (model thinks future cash will be higher than it turns out to be) to exceed \$5 million 2.5 percent of the time. Of 18 1-qtr forecasts evaluated in Table 1 and Table 2, + \$5 million was exceeded once, which is 5.5 percent of 18. We include these observations about model reliability recognizing that more experience and more rigorous analysis is required before statistically sound statements may be made.

1.8 Adjustments for Unchanged Rate Progress Billing

AIF activities performing research and development often use fixed rate job orders. The output is stated in terms of number of hours of project work, rather than in terms of a specific product. The reimbursement accrued per hour is based on a rate which includes components for direct labor, overhead and direct non-labor costs. The model already assumes that revenues accrued and expense for direct non-labor will be equal, and with this assumption no change is required to handle fixed rate job orders.

At Picatinny Arsenal, however, unchanged rate progress billing is used. Reimbursements are not based on current standard labor and overhead rates, but on the estimates when the job order was approved. Inflation becomes very important.

* The average unsigned error for two errors of -10 and +8 is 9.

** cf Brown, Robert G., Decision Rules for Inventory Management, Holt, Rinehart and Winston, New York, 1967.

Instead of using standard labor and overhead rates, the model bases reimbursement on recent history. The ratio of reimbursement earned for the past 3 months to direct hours worked is computed. This is termed the reimbursement rate. Future reimbursement is estimated by multiplying this rate by projected direct hours to be worked.

Because inflation is important, the model requires the input of dates for expected pay increases and the expected percents; there will be multiple dates in a year because of the timing of wage grade increases. Estimates of the growth in reimbursement rates are also input.

TABLE 1

RETROSPECTIVE RESULTS

DEPOT	LAST QTR ACTUAL LOW BAL	LOW BAL FORECAST		ERROR FORECAST - ACTUAL	
		1st QTR	2nd QTR	1st QTR	2nd QTR
ANAD	16.8	13.8	12.8	-.5	-3.2
	14.3	15.8	10.3	+2.8	-1.3
	13.0	11.9	10.9	+3.5	-5.2
LEAD	10.4	12.1	10.8	+1.2	+3.6
	10.9	14.3	14.9	+7.1	+8.0
	7.2	6.1	7.3	-0.8	-0.7
RRAD	9.5	9.5	5.8	+0.9	+1.5
	8.6	5.6	3.9	+1.3	-3.5
	5.1	2.8	4.2	+1.3	+0.3

TABLE 2

PILOT TEST RESULTS

DEPOT	LAST QTR ACTUAL LOW BAL	FORECAST	ERROR
ANAD	16.8	12.0	+1.6
	8.1	5.9	-2.5
	8.4	8.0	+1.4
LEAD	5.1	4.0	+0.3
	5.6	4.4	-1.7
	6.4	4.2	+0.2
RRAD	11.6	7.3	+0.7
	5.4	6.8	+2.9
	3.9	4.6	-3.5

APPENDIX - MODEL SPECIFICATIONS

A. INPUTS TO MODEL

Inputs Related to Current Position

The computer model is typically run monthly. The cutoff date for data will be the last day of the month which has just occurred; e.g. computer program is run 7 April, cutoff date is then 31 March. All inputs would then be as of 31 March.

CASH(0) - Activity cash as of cutoff date. Cutoff date is denoted time 0.
PAYBLE(0) - "Payables." Exclude labor. Include General Ledger Accounts (GLA's) 2102.00 + 2152.00 + 2155.00 + 2157.00 + 2220.00 + 2221.00.

Inputs Related to Hours Worked

TDH - "Total Direct Hours." Direct hours terminology as used on line 1 of IF-3 Report (DARCOM-P 37-4). Hours required for past 2 months
RLVPER - "Recent Leave Percent." Ratio of paid leave hours to total civilian hours for past 2 months.
HLVPER - "Historical Leave Percent." Historical ratio of paid leave hours to total civilian hours. Should be based on at least 1 year of history, and need be updated no more often than annually.
HLVFAC - "Historical Leave Factors," For each 1/2 month, % of annual paid leave historically taken in that period. These factors are included in model computer program and need not be input.

Inputs Related to Schedules

Disbursement dates for the latest and all future payrolls (at least for next 12 months).

Unreimbursed days. Number of calendar days in each month not billed for by end of month. For example, if the activity billing cycle was twice a month during a 31 day month, with the time frames being 1st to the 16th and 17th to the 31st, and collection was made only for the first billing cycle (1-16) during the

month, then that would leave 15 unreimbursed days in that month (31st - 16th = 15). Activities with billing cycles other than a monthly basis will have to compute accordingly to account for the month end status. An example would be if an activity bills weekly and collection is made one day after the weekly billing. If the sample month ended 4 days after the billing, then that activity would have 4 unreimbursed days. Unreimbursed days must be input for cutoff month and next 12 months. Installations which bill different orders at different times should refer to special instructions section.

Inputs Related to Costs/Collections

- TDMOC - "Total Direct Materiel and Other Costs."
GLA's 7121.00 + 7131.00 + 7151.00.
Required for past 4 months.
- OVR - "Overhead Rate."
Current rate used for progress billing purposes per direct hour.
- OVRP - "Overhead Rate Profit."
This is other than zero if OVR includes compensation for past profit or loss. OVRP is positive if future profit is to be generated, negative if loss is to be generated.
- OVRL - "Overhead Rate Labor."
That part of the overhead rate attributable to labor costs.
If unavailable, estimate as $(OVR - OVRP) \times (\% \text{ Labor})$ where % Labor is taken from IF-2 Report.*
- SLABR - "Standard Labor Rate."
Composite Labor Rate for the Activity.
- BLEDAY - "Payable Days."
Number of days of expenses,** on average, represented by payables.
Estimate as $(\text{average monthly payable} \div \text{average monthly non-payroll expenses}) \times 30$ (include in payables only those GLA's referenced in para I 1.), need be updated no more often than annually.

* Use lines $(2b + 2c) \div$ line 2, IF-2 Report (DARCOM-P 37-4).

** Use line 20, Statement B-2 (DARCOM-P 37-4) minus line 20b.

Inputs Related to Inflation

These inputs may be unnecessary. See "Special Instructions for Developing Inputs."

Julian dates of all expected payroll increases and expected percent increase.

Julian dates and percents for expected changes in standard labor rates, and overhead rates.

Inputs Conditional on Progress Billing Procedure

The following are to be used with referenced inputs by those activities who progress bill customers at the established fixed price/rate rather than at cost incurred up to the maximum amount of the order.

Hours Worked

UPBDH - "Unchanged Progress Billed Direct Hours."

That part of IDH attributable to orders which are progress billed at a constant or unchanged rate throughout the life of the order.

Costs/Collections

UPNDMOC - "Unchanged Progress Billed Direct Materiel and Other Costs."

That part of TDMOC attributable to orders which are progress billed at a constant or unchanged rate throughout the life of the order.

UPBRE - "Unchanged Progress Billed Reimbursement Earned."

Reimbursement earned on orders which are progress billed a constant or unchanged rate throughout the life of the order. Required for past 3 months.

Inflation

RGFAC - "Reimbursement Growth Factor."

Expected average monthly percent increase in reimbursements earned per direct hour on active orders progress billed at constant or unchanged rate throughout the life of the order. The monthly increases are created by phasing in of new

orders at higher reimbursement rates, to replace older orders with lower rates. For example, an order based on 1979-1980 labor rates is completed, and work is begun on an order based on 1980-1981 labor rates.

SPECIAL INSTRUCTIONS FOR DEVELOPING INPUTS

1. If an activity bills different orders at different times during the month, unreimbursed days (see input group 3) should represent a weighted average of unreimbursed days for each class of orders. Weights will reflect approximate proportional contribution of each class to yearly or quarterly collections.
2. Normally, the activity's cash balance, but not the USAFAC (Treasury) cash balance will be known when the model is run. However, if the USAFAC balance is known, it should be used for CASH(0), para I.1.
3. For activities which progress bill exclusively based on costs incurred, inflation input is unnecessary.

B. VARIABLES COMPUTED BY MODEL

Variables Related to Hours Worked

- WKDAYS (t_1, t_2) - Model can figure out number of weekdays between any two dates (t_1, t_2); e.g. t_1 might be Julian date 9038 and t_2 might be 9092.
- TPDH - "Total Potential Direct Hours."
Model increases historical direct hours input by estimated paid leave per hour (found from RLVPER^{*}) to get estimated hours if there were no leave.
- HPWD - Model estimates potential number of direct hours which will accrue each weekday by using 2^{**} months of history; i.e. it divides total potential direct hours worked in last 2 months by number of weekdays in last 2 months.
- PDH(t_1, t_2) - Model estimates number of potential direct hours accrued between t_1 and t_2 by using variables just described.

$$PDH(t_1, t_2) = WKDAYS(t_1, t_2) \times HPWD$$

- LEAVE (t_1, t_2) - Model estimates number of direct hours which will represent leave by multiplying PDH(t_1, t_2) by (HLVPER) x (appropriate HLVFAC). HLVPER and HLVFAC are discussed in the input. The HLVFAC covering the period of interest (t_1, t_2) are selected.

- DH(t_1, t_2) - Model estimates direct hours as

$$DH(t_1, t_2) = PDH(t_1, t_2) - LEAVE(t_1, t_2)$$

Variables Related to Costs

- TDMOCH - Model estimates "Total Direct Materiel and Other Costs" per direct hour worked by using 3^{**} months of history; i.e., it divides direct and other materiel cost for last 3 months of history by number of direct hours worked those months.

*Because RLVPER represents paid leave per total hours, not per worked hours, an algebraic equation is first solved. $TPDH \cdot (1 - RLVPER) = \text{Direct Hours Input}$.

** Historical parameters found by statistical analysis.

Variables Related to Costs (cont)

PAYROLL_{ADJ} - Payroll costs per pay period are found by averaging the four most recent payrolls. Payroll is appropriately adjusted for any future increases which are specified in the input.

UPBRH - Model estimates "Unchanged Progress Billed Reimbursement per Direct Hour" using 3 months of history.

RGFAC(t_1, t_2) - Applicable inflation rate for the period from t_1 to t_2 , taking into account RGFAC (the rate per month), the number of months from cutoff to t_1 , and the number of months from t_1 to t_2 .

C. MODEL EQUATIONS

The basic model equations are first listed, then explained.

$$(1) \quad \text{CASH}(t) = \text{CASH}(0) + \text{REIMBURSEMENTS}(0,t) - \text{EXPENSES}(0,t) \\ + \text{PAYABLES}(t) - \text{PAYABLES}(0)$$

$$(2) \quad \text{REIMBURSEMENTS}(0,t) = \text{REIMBURSEMENT ACCRUED}(t_1, t_2) =$$

Unchanged Progress Billing Rate:

$$(2a) \quad \text{UPBDH}(t_1, t_2) \times \text{UPBRH} \times \text{RGFAC}(t_1, t_2)$$

Other (Including Fixed Price):

$$(2b) \quad [\text{TDH}(t_1, t_2) - \text{UPBDH}(t_1, t_2)] \times [\text{SLABR}(t_1, t_2) + \text{OVR}(t_1, t_2) \\ + \text{TDMOCH} \times \text{RGFAC}(t_1, t_2)]$$

(3) EXPENSES

$$(3a) \quad \text{LABOR EXPENSES} = (\text{PAYROLL}_{\text{adj}}) \times N$$

N = number of payroll validation dates between current date
and time t

$$(3b) \quad \text{EXPENSES}(0,t) = \text{LABOR EXPENSES}(0,t) + \text{TDH}(0,t) \times \text{TDMOCH} \\ \times \text{RGFAC}(0,t) + \text{TDH}(0,t) \times [\text{OVR}(0,t) \\ - \text{OVRP} - \text{OVRL}(0,t)]$$

(4) PAYABLES

$$\text{PAYABLES}(t) = (\text{Projected Non Labor Expenses Per Day}) \times \text{BLEDAY}$$

Equation (1)

This equation states that CASH at some future time, denoted t , equals present cash plus the difference between reimbursements and expenses, adjusted for changes in payables. An increase in payables increases cash, until such time as the payable is liquidated.

Equation (2)

Note that the reimbursement period $(0,t)$ does not coincide exactly with the period for which hours are accumulated (t_1,t_2) . For example, suppose a forecast is made for the period 1 May thru 31 July. Collections during that period might cover the period 16 April thru 16 July; i.e. hours worked 16 April thru 30 April might not have been billed until May.

Equation (2a)

Currently, reimbursements are at the average rate of UPBRH per direct hour, so that in the absence of inflation we would multiply this rate by direct hours - UPBDH(t_1,t_2) in the period of interest. RGFAC(t_1,t_2) represents the average increase in billing rate over this period.

Equation (2b)

Unchanged progress billing rate hours are subtracted from total direct hours to determine hours billed on other basis, e.g., fixed price or cost reimbursable. SLABR(t_1,t_2) is the average standard labor rate over (t_1,t_2) found from the current rate adjusted for any expected increases. OVR(t_1,t_2) is the average overhead rate, and TDMOCH is direct cost per hour excluding labor and overhead. RGFAC will normally have default value of 1 and have no effect.

Equation (3)

Equation (3a) is self-explanatory. Historical payroll costs are adjusted for any anticipated increase. In equation (3b) direct hours are multiplied by all non-labor costs, which have been determined on a per hour basis. It is assumed overhead rates reflect actual overhead costs.

Equation (4)

To get payables as of some future date t , we estimate the average expenses per day, net of labor, in the 30 day period ending on day t , and multiply by BLEDAY (see input variables).

D. MANUAL ADJUSTMENTS

There are a number of reasons why the cash projections made by the computerized cash flow model might require some manual adjustment.

Some of these are:

- a. Changes in operating policies or special events which make historical data unrepresentative of future trends.
- b. Profits or Losses which are not known until the completion of an order. These occur when we progress bill on costs incurred rather than at the fixed price/rate of the order, or when hours estimated to do work was incorrect.

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